WED Transportation Systems Inc.

# WEDWAY PEOPLEMOVER

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# 2 Twenty Years of Transportation Solutions

It started in 1955 at DISNEYLAND with double decker buses and riverboats. Already a "mini-city" in transportation activities, Disneyland introduced the first daily monorail service in 1959. The design and development of the monorail system reflected Walt Disney's personal commitment to not only build an attraction, but more importantly to provide a transportation system for the future.

In 1964, the first Disney-designed PeopleMover system carried guests through the Ford pavilion at the New York World's Fair.

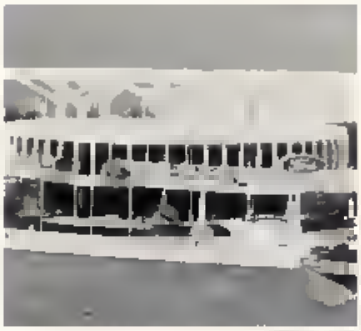
Than three years later, Disneyland inaugurated a similar system which annually carries 4 million passengers and is still in operation today.

In 1975, at WALT DISNEY WORLD in Florida, the WEDway PeopleMover began daily operations utilizing a linear induction propulsion system to economically transport thousands of guests silently every day. This unique transportation system has met the requirements of the Urban Mass Transportation Administration for application as a downtown people mover, and received that agency's certification in May 1976.

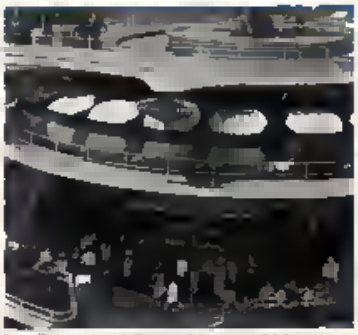
In the summer of 1981, Disney's first public application of the WEDway PeopleMover opened at Houston's Intercontinental Airport. Serving three airline terminals, a hotel and remote parking area, this fourth generation system has established a reliability record exceeding 99.6% during the first year of operation. The success of the Houston Airport PeopleMover is confirmation that the concepts and technologies proven in the Disney Parks can be effectively employed in other public applications.

WED Transportation Systems represents two decades of research, development, construction, testing and operation of transportation systems — systems that not only provide solutions to Walt Disney Productions' needs, but also provide solutions to the transportation needs of today's cities.

WED Transportation Systems will develop the transportation systems and technologies to be showcased in the EPCOT Center at the WALT DISNEY WORLD Resort Complex in a continuing effort to provide clean, efficient transportation to cities throughout the world.



PeopleMoving at the New York World's Fair (1964)



The Disneyland PeopleMover (1967)

The linear induction WEDway PeopleMover at WALT DISNEY WORLD (1975)

The Houston Airport WEDway PeopleMover (1981)

# 3 System Overview

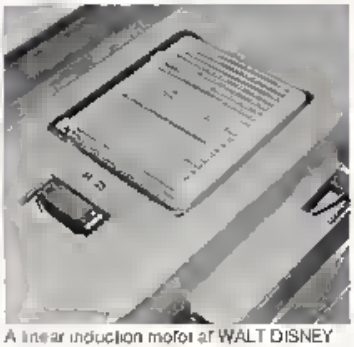
DISNEYLAND S PeopleMover units consist of four adjoining vehicles forming a 16-passenger 'train.' Each train is propelled by electric motor-driven rubber wheels imbedded in a track guideway which is supported by an elevated concrete roadbed. Control systems permit varying speed zones along the route. Nonstop passenger loading and unloading is accomplished from a circular belt rotating at the speed of the passing vehicle.

The third generation WEDway PeopleMover System, installed at WALT DISNEY WORLD in 1975, is a passive vehicle system which operates on guide rails and is propelled by track-mounted linear induction motors. Vehicle speed, collision protection, and spacing are computer-monitored through proximity and speed sensors which control power to each motor as a car enters its reactive zone, thus optimizing energy utilization. Each five-car train moves 20 passengers at between one and 10 FPS (feet per second) at a minimum 20-second headway.

The chassis is supported by urethane-covered aluminum guide and support wheels which ride on steel tracks. The wheels, which are the only moving parts necessary for the car's operation, insure low noise and friction levels. The track rails are supported by a welded steel frame and either concrete or steel piers. The system is not affected by wind, heat or moisture, and the only sound generated is from the contact of the wheels on the track as they roll.

The fourth generation WEDway PeopleMover at Houston Intercontinental Airport was opened in August 1981. In competitive bidding with four other technologies, the City of Houston selected the Disney system after ranking it technically superior and the most cost effective. Based on the same passive vehicle linear induction propulsion system as was used in the WALT DISNEY WORLD WEDway PeopleMover, the Houston Airport PeopleMover has the added features of full-stop stations using elevator-type doors, larger fully enclosed vehicles, and speeds up to 15 mph. Operating 22 hours a day on a 1.5-mile loop, the Houston system achieved a 99.6% reliability over the entire first ten months of operation, making it one of the most dependable, fully automated people movers in service today. This record was established with only two Disney maintenance technicians on each of three shifts, including clerical and management support, the total maintenance and operating staff consists of 11 people.

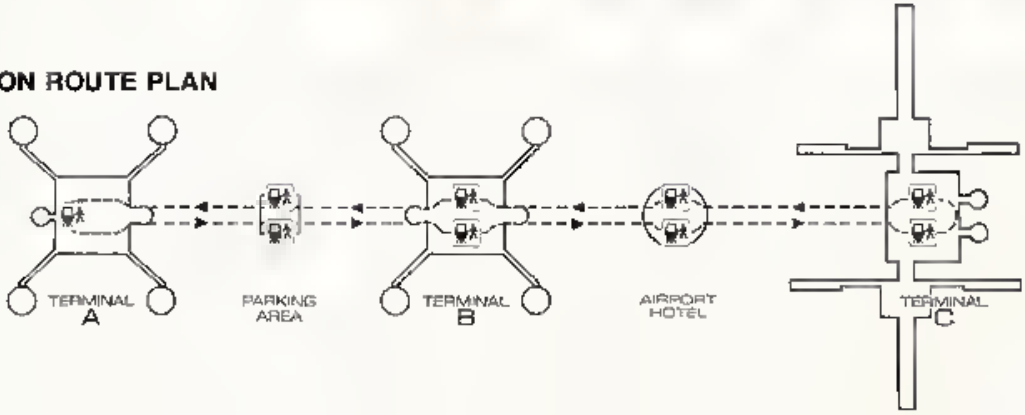
Installation of the system required two years and was undertaken by a joint venture with Turner Construction Company. The DISNEY-TURNER Team provided a total turn key project under one entity offering a unique blend of construction and systems design experience.



A linear induction motor at WALT DISNEY WORLD

Houston passive vehicle

**HOUSTON ROUTE PLAN**



# 4 Drive System

The WEDway PeopleMover is driven by a linear induction propulsion system which efficiently translates thrust directly to the vehicle without intervening gears, belts, or other mechanical devices. Rectangular (10" x 15" x 2-1/2" thick) electromagnetic motors are attached to the roadbed between the two guide rails. The motors react upon an aluminum-laced steel platen plate which is mounted beneath each car. The air gap between motor and platen is maintained at a separation of .150 inch, ± .010 inch.

The motors are turned on by proximity sensors only when a platen approaches, providing thrust in either direction as required. Vehicle speed, which is determined by sensors adjacent to each motor, is regulated by the duration of power applied to each motor.

Station motors produce a maximum of 125 pounds thrust and require 240 volts, 60 Hz, 40 amps to operate.

Linear Induction Motor

Houston linear motor drive system

The motors in the cruise areas have a synchronous speed of 20 mph although top operating speed is limited to 15 mph. Higher speeds are readily attainable should guideway configurations permit.

Motor spacing along the track varies with vehicle speed, grade, acceleration rates and number of vehicles connected together. For a constant velocity three car train, 12 feet between motors delivers the required thrust with approximately a 100% motor safety factor.

The motors, with normal use, have an unlimited life expectancy. The only routine maintenance required is minimum visual inspection of electrical connections.

Since power collection is not used in the passive vehicle system, exposed electricity along the guideway has been totally eliminated enhancing system safety.

# 6 Vehicles

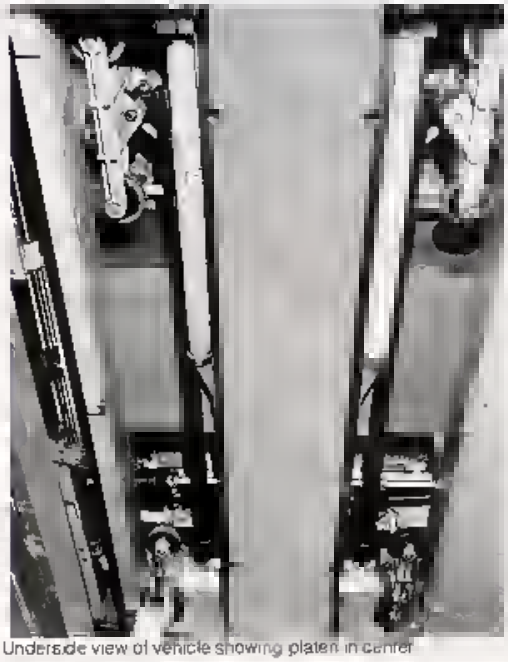
The Houston vehicle consists of a body cushion-mounted on a solid chassis assembly fitted with 12 urethane-covered aluminum wheels (eight guide and four support). Each bogie assembly is attached to the chassis through a kingpin, which permits the chassis to be steered from both the front and back. An aluminum-faced steel platen attached to the underside of the chassis serves as the reactive part of the linear motor drive system. Since all propulsion power is supplied to the track mounted part of the motor, the vehicle can remain completely passive.

The Houston system contains six three-car trains, each carrying a total of 36 passengers with accommodations for luggage. Each car in a train has room for six seated and six standing passengers. Wheelchairs may also be boarded on any of the three cars.

The unique operating environment in an underground tunnel allows air-conditioning of the passive vehicles by circulating the conditioned air in the tunnel complex through the gratings in the top of each car. As the train moves louvers on the front and back of each car also force air into the vehicle.

Because the PeopleMover vehicles are passive with no on-board equipment, the empty weight of each car is only 2,400 lbs. The light weight coupled with the extremely low rolling friction of the urethane wheels provide a very energy efficient vehicle.

Houston passive vehicle



Underside view of vehicle showing platen in center

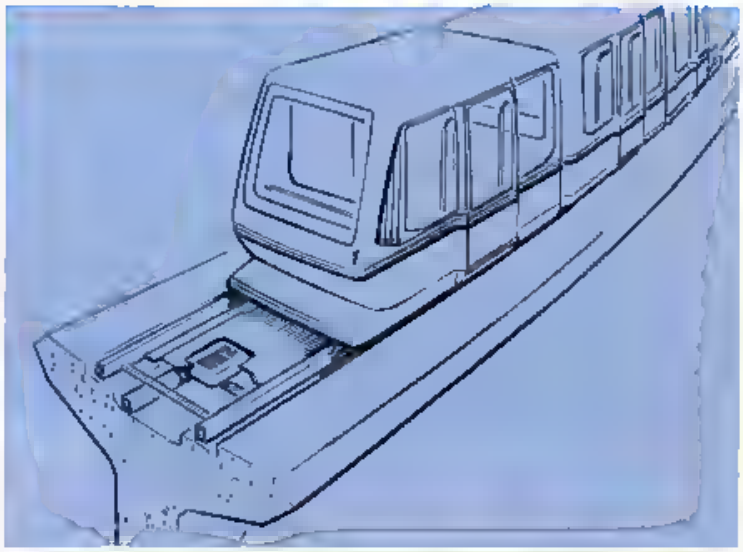
# 7 Track and Support

WEDway's track is constructed of structural steel tubing capable of containing power wiring. The track is bolted to a concrete or steel bed for support and rigidity. The motors, spaced between the track, are shimmed to the correct height to provide the necessary motor/platen air gap clearance. In elevated track applications, prestressed concrete or steel piers provide support. Foundation construction type is determined by local soil conditions.

Although current vehicles travel on a relatively flat plane, they can be propelled on any angle depending on the power supplied to the motors. Passenger comfort limits track angle to approximately 15% and track curves to a minimum 20-foot radius.

Both Houston and WALT DISNEY WORLD systems presently utilize mechanical track switching between the main line and the spur track. Automatic switching has been manufactured and has undergone reliability tests. The switch can receive its control from the vehicle destination command.

Track support and pier profiles can be designed to aesthetically blend into the surrounding environment.



# 8 Automation

The WEDway PeopleMover is a fully automated system. Control activities are decentralized through distributed local controllers in the stations and cruise zones. Hard-wired communications between adjacent controllers insure safe operations and allow a central monitoring computer to provide instantaneous detection of a malfunction. Since the central monitoring computer is not required for system operation, overall reliability is greatly enhanced.

Station control in Houston is accomplished in each station by a redundant pair of logic elements each using a single board microcomputer. The station logic supervises station stopping control, operates the doors, selects dwell time, operates station and safety brakes, and the local station control panel. Manual station operation is possible in the event of certain malfunctions.

Cruise areas between stations provide block control safety zones which hand-off trains from one zone to the next. Individual linear motors in a specific zone are controlled by microprocessor based logic cards which select the appropriate power commands to each motor. Motor redundancy allows the system to continue operation in the event of single or multiple motor failures.

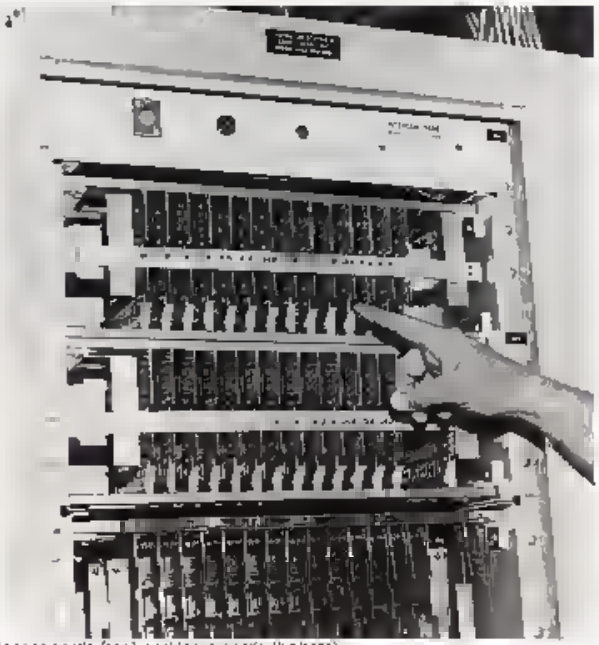
Train separation is maintained by two independent fail-safe systems. The various motor control centers form train detection zones along the route and inhibit motor power to zones behind a train. This creates a traveling "dead-zone" behind each train and insures that trains cannot be powered into one another. Stations and their associated redundant mechanical safety brakes create the second separation system. Station logic prevents dispatch of a train until the next station and the enroute cruise zones are unoccupied. The station safety block is protected by dual mechanical safety brakes outside each station to insure safe operations in the event of a total loss of electrical power.

A central control area provides real-time monitoring of all major subsystems and operational performance. Closed-circuit television monitors each station area for increased security. Special announcements or instructions to waiting passengers may also be generated from the central control area. The central control room in Houston is co-located within the maintenance area. The two on-duty operators can simultaneously perform routine maintenance on vehicles, stations, and track-side equipment since the monitoring activities of the central control room activate audio

Houston control room

and visual alarms in the event of a malfunction

The current WALT DISNEY WORLD WEDway operates in a closed loop with continuously moving cars. A further developed system is being designed which will permit cars to remain idle until summoned. A "destination command" panel on each vehicle will enable passengers to push the appropriate button corresponding to their desired destination. Vehicle doors will close automatically, permitting the car to be dispatched to the new location. Off-line loading will enable vehicles to bypass unwanted locations and continue without time-consuming stops. Track switching will be controlled by the destination command in the vehicle. Full-stop stations using elevator-type doors have been developed for systems requiring static loading such as the Houston Airport.



Sensor cards (top) and logic cards (bottom)

# 10 System Operations

The Houston WEDway PeopleMover operates 22 hours a day 365 days a year. Five, three-car trains operate underground on a mile and a half track, serving three airline terminal buildings, a 570 room hotel and a remote parking area. Trains arrive every three minutes providing convenient interconnect service with the longest trip time being less than seven minutes including stops.

Nine stations along the 7,200 feet of guideway utilize standard elevator-type doors. The station door operators also open and close the vehicle doors in unison for all three cars in a train. Sensitive door edges infrared beams, and door hold buttons provide additional control and safety in the stations. Prerecorded audio announcements are made prior to arrival at each station. In addition, special announcements can be made to all waiting areas, vehicles and walkways should an emergency arise or abnormal condition occur.

Station dwell times are preset at 20 seconds and an alarm is sounded in central control if actual dwell time exceeds 30 seconds.

Handicapped persons may be accommodated through the wide-access doors of the Houston WEDway. Closed-circuit television monitors provide additional information to the central control room in the event passengers have difficulty in boarding.

The operations and maintenance of the Houston Airport PeopleMover for five years was contracted by the city of Houston during the original bidding process for system installation. Performance of the system was guaranteed to exceed 99.6% after the first six months of operation. A severe financial penalty is applied should this performance criteria not be attained. The Houston WEDway system operated at 99.6% reliability during the entire first six months of operation.

Elevator type station doors

# 11 Maintenance

Elevated work track in maintenance area

Maintenance in Houston is conducted by nine Disney technicians who work in two-man teams to cover the 24-hour operating requirement seven days per week. The maintenance area consists of a spur track, central control room, electronics maintenance/repair room, a small office, and an elevated maintenance track for one train.

A regular preventive maintenance program insures a minimum of unscheduled services. The passive vehicles require little more than custodial upkeep aside from their scheduled maintenance. Station and track-side equipment is checked daily for operation. Track-side repairs when necessary are conducted during the two hours of non-operational time each night. Nearly all electronics maintenance can be performed without entering the guideway or requiring system shutdown. Self-diagnostic designs aid in isolating specific faults at the card level.

# 12 Applications

## Performance

In July 1975 Disney introduced the first linear induction WEDway PeopleMover which has now been in daily service at WALT DISNEY WORLD for over seven years. A similar improved WEDway System opened at Houston Intercontinental Airport in 1981. The WEDway PeopleMover has proven to be a safe, reliable, and economical system. The following facts demonstrate the success of this system.

*Safety* – Over 30 million passengers have been carried without an injury caused by system performance. Over 4 million vehicle miles have been traveled without a vehicle collision.

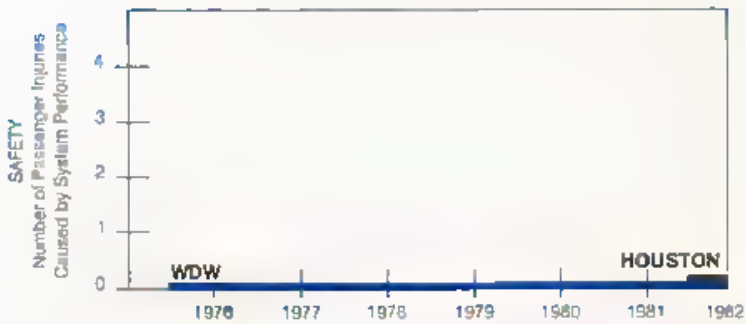
*Reliability* – The operational readiness of the system has exceeded 99% for each installation.

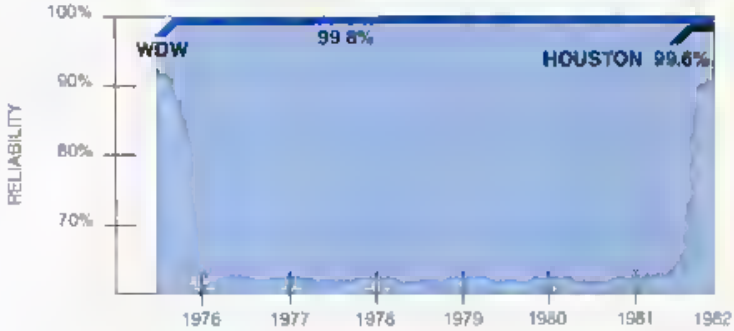
*Operating Costs* – The nine cents per passenger mile of total operating and maintenance cost was the lowest of any of the 10 people-mover systems evaluated by the Urban Mass Transportation Administration.

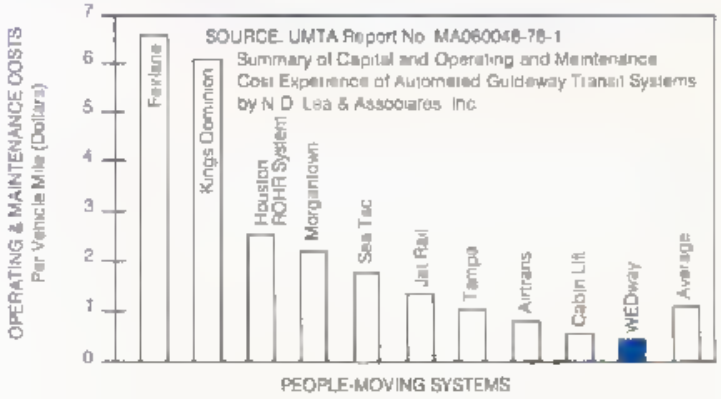
## Applications

The application of the WEDway PeopleMover system for airports, shopping centers, and other developments is an extension of a time proven technology. More importantly, the blending of technology, the environment, and people into an effective transportation system requires an understanding of both the science of transportation equipment and the art of handling people. In the past 25 years, Disney has been fortunate to have the Theme Park proving grounds for the development and testing of new people-oriented people movers. This privately funded effort to improve transportation for our citizens and communities was pursued without the traditional limitations to try new concepts and ideas imposed by government regulations or other funding institutions. The operational and economic success of the Houston Airport PeopleMover is a clear statement of the value of this unique transportation development effort.

WEDway PeopleMover Operating History



# 13 Walt Disney World System

## Operating history

The first linear motor WEDway system installed at WALT DISNEY WORLD required two years to design and one year for construction

Since its introduction in July 1975, the system has been in daily operation for over 30,000 hours, averaging 12 hours per day with 99 8% operational readiness

The application of the WEDway PeopleMover in the WALT DISNEY WORLD Magic Kingdom is designed to provide visitors a preview of the various futuristic attractions found along its route in Tomorrowland The 10 minute ride is a demonstration itself of a new transportation technology using the linear motor

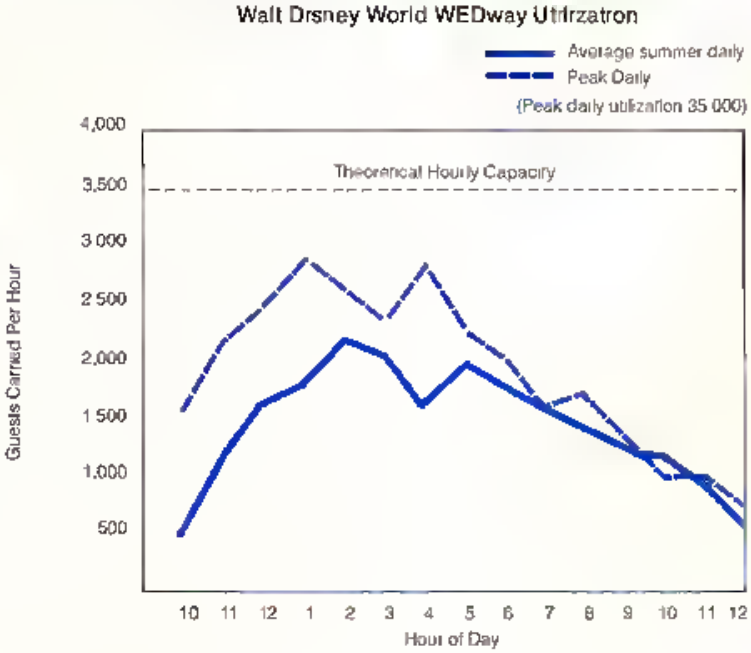
Routine maintenance of the vehicles is done on a nearby spur line, while major rehabilitation of cars can be performed in an off-line maintenance facility On a routine basis, checks are necessary on electrical connections door alignment, and wheel tightness and wear Annual maintenance operations include refurbishing wheels and bearings as necessary, repainting vehicle interiors, inspecting the track for wear, and thoroughly checking electrical systems Because of the system's simplicity and resulting minimal maintenance requirements the WEDway PeopleMover has traditionally had only two (2) full time personnel assigned for routine maintenance activities

## Environmental

Vehicle noise is limited to contact between the wheels and expansion gaps in the track The WEDway System creates no air pollution because it relies upon externally supplied electrical energy In addition, it disturbs only that portion of the terrain where the piers are placed on the ground

Since all drive and braking propulsion is supplied by the linear motor, there is no traction requirement between the wheels and the track Consequently, heat, dust, wind, and moisture have no effect on the system's operation

Any ice that may form on the motors is melted by the heat generated during the first few minutes of operation. The front bumper and track sweeper of each vehicle removes snow from the track. The only condition that would limit vehicle operation is excessive snow or ice which would completely prevent vehicle movement



# 14 WEDway System Summary

## DESIGN

The design parameters below describe the specific applications of the WEDway PeopleMover at WALT DISNEY WORLD and Houston's Intercontinental Airport. These characteristics are not the limits of capability or performance, but are indicative of typical features needed for the efficient movement of people in high-density developments. Variations in vehicle size, speed, and other system elements are readily available without major modification of the WEDway's flexible linear induction propulsion and control systems.

## SYSTEM PERFORMANCE

| | Houston | WALT DISNEY WORLD |
|---|---|---|
| Maximum Theoretical One-way Capacity (passengers/hour) | 1,680 | 3,500 |
| Mode of Operation | Closed-loop | Closed-loop |
| Reliability — 1981 | 99.6% | 99.9% |
| Operating Hours — 1981 | 2,680 (Aug 17 - Dec 31) | 4,114 |

## VEHICLE PERFORMANCE

| | Units | Houston | WALT DISNEY WORLD |
|---|---|---|---|
| Speed | (MPH) | 15 | 7 |
| | (FPS) | 22 | 10 |
| Acceleration | (FPS/S) | 3.7 | 2.5 |
| Deceleration | (FPS/S) | 4.4 | 2.5 |
| Emergency Stop | (FPS/S) | 11.8 | 11.0 |
| Stopping Precision | (inches) | ±6 | NA |
| Traction Requirement | — | NONE | NONE |

## VEHICLE CHARACTERISTICS

| | Units | Houston | WALT DISNEY WORLD |
|---|---|---|---|
| Body Type | — | fully-enclosed | open-topped |
| Wheel Base | (inches) | 102 | 54 |
| Overall Length | (inches) | 163 | 100 |
| Overall Width | (inches) | 62 | 57 |
| Overall Height | (inches) | 92 | 45 (open car) |
| Empty Weight | (pounds) | 2,400 | 1,000 |
| Gross Weight | (pounds) | 4,400 | 1,800 |
| Doorway Width | (inches) | 42 | 22 |
| Power Collection | — | NONE | NONE |
| Hydraulics | — | NONE | NONE |
| Passengers Per Car | — | 12 with luggage | 4 |
| Cars Per Train | — | 3 | 5 |
| Train Capacity | — | 36 | 20 |

## OPERATING COSTS — 1981*

| | Houston | WALT DISNEY WORLD |
|---|---|---|
| Maintenance | $219,000 | $140,000 |
| Operations | 109,000 | 173,000 (1) |
| Energy | 12,000 | 68,000 |
| Total | $340,000 | $381,000 |
| | (6 months) | (12 months) |

(1) These costs include 12 "masters and greeters" that assist in loading and off-loading on the moving turntable.

* These are 1981 operating costs experienced at the locations shown and due to numerous variables (labor rates, electric rates, operating hours) they may vary significantly in other applications.

## SUSPENSION

TYPE Rigid bogie with shock dampened body
DESIGN LOAD 100% safety factor

LATERAL GUIDANCE Front and rear guide wheels which steer the bogie through kingpins and tie rods

## PROPULSION AND BRAKING

| | Units | Houston | WALT DISNEY WORLD |
|---|---|---|---|
| | | XXXX | YYYY |
| Motor Type | — | Linear Induction, active track motor, passive car platen | |
| Motor Placement | | | |
| Stations | (Ft.) | 3 | 3 |
| Cruise Areas | (Ft.) | 12 | 10 |
| Motor Rating — Power | — | 240V 60Hz, 3ϕ | 240V, 60Hz, 3ϕ |
| Thrust | (Lbs.) | 125 | 90 |
| Motor Control | — | Speed and Proximity Sensors operating through control logic | |
| Braking — Service | — | Linear Motor Reverse Polarity | Linear Motor Reverse Polarity |
| Station Docking | — | Mechanical Caliper - 2 Ft | — N.A. |
| Emergency Stop | — | Mechanical Caliper - 6 Ft. | Linear Motor Reverse Polarity |

## GUIDEWAY

| | Units | | |
|---|---|---|---|
| Type | | Concrete-tunnel | Concrete-elevated |
| Minimum Turn Radius | (Ft.) | 20 | 20 |

## SINGLE LANE GUIDEWAY

| | | |
|---|---|---|
| Maximum Span | N.A. | 70-90 feet |
| Cross-section width (ft-inches) | 7'9" | 6'4" |
| Cross-section height (ft-inches) | 10'4" | 5'0" |
| Design load (lbs-ft) (Supportive load) | 500 | 500 |

## STATIONS

| | | |
|---|---|---|
| Number | 9 | 1 |
| Type | full-stop, elevator doors, 3 sets | rotating turntable |
| On Line/Off-Line | on-line | on-line |
| Dwell (seconds) | 15-20 (variable) | 20 |

## SWITCHING

| | | |
|---|---|---|
| Type | Manual Operating | Manual Operating |
| Speed Through Switch | | |

**NOTE:** Automatic switching has been developed and tested with 3-second lock-to-lock for use with systems utilizing the vehicle destination selection feature.

**WED Transportation Systems Inc.**

*A Subsidiary of Walt Disney Productions*

Post Office Box 40
Lake Buena Vista, Florida 32830
Telephone (305) 824-5050